VERIFICATION OF TRANSLATION

I, Tae-Ho Ha of 4th Floor, Susan Bldg., 824-9, Yeoksam-dong, Gangnam-gu, Seoul, 135-080, Republic of Korea, declare that I have a thorough knowledge of the Korean and English languages, and the writings contained in the following pages are correct English translation of the specification and claims of Korean Patent Application No. 2001-0030698.

This 20nd day of May, 2005

By:

[Tae-Ho Ha]

KOREAN INTELLECTUAL

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[TITLE OF INVENTION IN KOREAN] 실리콘 결정화방법

[TITLE OF INVENTION IN ENGLISH] A method of crystallinzing Si

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[EXAMINATION REQUEST] Request

[PURPORT] We submit application as above under the article 42 of the Patent Law, and request examination of application as above under the article 60 of the Patent Law.

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[FEES]

[BASIC APPLICATION FEE]	20 pages	29,000	Won
[ADDITIONAL APPLICATION FEE]	16 pages	16,000	Won
[PRIORITY FEE]	0 things	0	won
[EXAMINATION REQUEST FEE]	12 clamis	493,000	Won
[TOTAL]		538,000	Won

[ENCLOSED] 1. Abstract, Specifications (with Drawings) – 1 set

[DOCUMENT OF ABSTRACT]

[ABSTRACT]

The present invention relates to a silicon crystallization method, more particularly, to a method of inducing a lateral growth of a grain (SLS : sequential lateral solidification) out of silicon crystallization methods using a laser beam at a low temperature.

In general, when a laser beam is irradiated on a mask having a transmission region and a shielding region, a laser beam pattern is formed according to a shape of the transmission region of the mask.

At this point, when the laser beam having the predetermined pattern is irradiated to an amorphous thin film, crystallization is achieved by the pattern and thus laser beam crystallization is achieved.

In the conventional art, a laser is irradiated by moving a mask having a transmission region where both edge portions have a rectangular stripe shape, and thus amorphous silicon is crystallized.

In such method, there is a problem that a circular-shaped crystallization discontinuity is generated at an edge portion where a first beam pattern and a second beam pattern meet each other. Accordingly, when such discontinuous crystals is used for fabricating a thin film transistor, electric characteristics of the thin film transistor are discontinuous and thus operating characteristics of a panel is degraded.

To solving such problem, in the present invention, an edge portion of the transmission region formed in a horizontal direction of the mask has a triangular shape.

When crystallization is performed using such mask, in a crystallized region corresponding to the edge portion of the transmission region, a uniform crystal growth of a grain is generated, and thus a device using it has stable characteristics.

[REPRESENTATIVE FIGURE]

FIG. 6a

[SPECIFICATIONS]

[NAME OF INVENTION]

A method of crystallizing Si

[BRIEF EXPLANATION OF FIGURES]

FIG 1 is a view showing a SLS crystallization apparatus,

FIG. 2 is a view showing a substrate where crystallization is performed partially,

FIGs. 3a to 3c are plan views showing crystallization processes according to the conventional example,

FIG. 4 is a plan view showing a mask according to a first embodiment of the present invention,

FIGs. 5a to 5c are plan views showing crystallization processes according to a first embodiment of the present invention,

FIGs. 6a and 6b are plan views masks according to a second embodiment of the present invention,

FIGs. 7a to 7d are plan views showing crystallization processes according to a first embodiment of the present invention,

FIG. 8 is a schematic plan view showing a liquid crystal panel, and

FIG. 9 is a schematic cross-sectional view showing a driving device and a switching device in the liquid crystal panel.

< Explanation of major parts in the figures >

200 : mask 202 : shielding region

203 : transmitting region L : triangular-shaped edge portion of the transmitting region of the mask

[DETAILED DESCRIPTION OF INVENTION]

[OBJECT OF INVENTION]

[TECHNICAL FIELD OF THE INVENTION AND PRIOR ART OF THE FIELD]

The present invention relates to a method of forming a poly silicon at a low temperature, and more particularly, to a crystallization method of inducing a lateral growth of a grain.

In general, silicon is categorized into amorphous silicon and crystalline silicon according to crystallization phase.

Since amorphous silicon can be deposited at a low temperature to form a thin film on a glass substrate, it is commonly used in a switching device of a liquid crystal display device which uses a glass substrate having a low melting temperature.

However, when amorphous silicon is used, a driving device of the liquid crystal display device has low electric property and reliability and the liquid crystal display device has a difficulty for large display size.

Common uses of high fine image driving circuits for a panel, integrated laptop computers and liquid crystal display devices for a wall-mounted television require pixel driving devices having high electric characteristics (for example, a high electric field effect mobility (30 cm^2/VS), a high frequency operation property and a low leakage current). To do this, application of high quality poly crystalline silicon is required.

In particular, electric characteristics of a poly crystalline thin film are influenced mainly by a grain size. In other words, as the grain size is larger, the electric field effect mobility is larger.

Thus, a single crystallization method of silicon becomes a main issue. Presently, a sequential lateral solidification (SLS) technology that a lateral growth of a silicon crystal is induced by a laser beam as a energy source and thus a huge single crystalline silicon is formed, is proposed in WO Pub. No. 97/45827 and KR Pub. No. 2001-004129.

The SLS crystallization technology uses the fact that silicon grains tend to grow laterally from the interface between liquid and solid silicon into a direction perpendicular to the interface. With SLS, amorphous silicon is crystallized by controlling a magnitude and an irradiation range of a laser beam such that a silicon grain is laterally grown by a predetermined length.

The SLS device performing the SLS crystallization technology is shown in FIG. 1.

The SLS apparatus 32 includes a laser generator 36 generating a laser beam 34, a condenser lens 40 condensing the laser beam emitted from the laser generator 36, a mask 38 dividing the laser beam and irradiating it to a substrate 44, a reducing lens 42 disposed on or below the mask 38 and reducing the laser beam 34 by a predetermined ratio.

The laser generator 36 emits the laser beam 34 not treated in a laser source and adjusts the intensity of the laser beam through an attenuator (not shown). Then, the laser beam is irradiated through the condenser lens 40.

An X-Y stage 46 where the substrate 44 having a amorphous silicon thin film is fixed is disposed at a position corresponding to the mask 38.

At this point, to crystallize the entire area of the substrate 44, the X-Y stage 46 is moved minutely such that the crystallized region is expanded.

The mask 38 includes a transmitting region "A" transmitting the laser beam and a shielding region "B" shielding the laser beam.

The width of the shielding region "B" (a distance between the transmitting regions) determines a lateral growth length of a grain.

A method of crystallizing silicon using the conventional SLS apparatus is explained.

In general, crystalline silicon is formed by forming a buffer layer (not shown) as a insulating layer on the substrate, depositing an amorphous preceding film on the buffer layer and using it. The amorphous preceding film is deposited generally with a chemical vaporization deposition (CVD) method and has a lot of hydrogen therein.

Since hydrogen has a characteristic of leaving a thin film by a thermal, a de-hydrogenation is required that the amorphous preceding film is firstly thermal-treated.

That is because the surface of the crystalline thin film is very rough and thus the electric characteristics are degraded if the de-hydrogenation is not performed.

FIG. 2 shows a substrate 54 where a partially-crystallized amorphous silicon film 52 is formed by the de-hydrogenation.

As shown, when performing SLS crystallization, it is difficult to crystallize all of the amorphous silicon film 52 at once.

That is because the laser beam has a limited beam width and the mask (38 of FIG. 1) has a limited size. Therefore, as the size of the substrate is larger, the one mask (38 of FIG. 1) is rearranged numerous times over the substrate, while crystallization is repeated for the one mask rearrangements.

At this point, if a crystallized region corresponding to a reduced area "C" of the one mask is defined as a block, crystallization within the one block also is achieved by irradiating the laser beam several times.

FIGs. 3a to 3c are plan views sequentially showing the conventional crystallization processes of amorphous silicon film using the SLS apparatus. (At this point, an example of crystallization for one block of FIG. 2 is explained. Also, supposing that the mask has three slits.)

FIG. 3a is a view showing a step of crystallizing amorphous silicon into crystalline silicon when a first laser beam is irradiated.

At first, the first laser beam is irradiated through the mask (not shown) on the amorphous silicon thin film 52. At this point, the irradiated laser beam is divided by the multiple slits (transmitting regions) ("A" of FIG. 1) and melts and liquefies regions "D", "E" and "F" of the amorphous silicon thin film 52. In such process, the energy density of the laser beam uses a complete melting regime to completely melt the amorphous silicon film.

When the irradiation of the laser beam is finished, the completely melted liquid phase silicon begins to be crystallized at the interface 56 between the amorphous silicon region and the liquid phase silicon region. The lateral grain growth is generated perpendicularly to the interface 56.

In general, the length of lateral grain growth attained by a laser beam irradiation has a range from 1 to 1.5 micrometers (μm). If the beam pattern is larger than twice the lateral grain growth length, a region where the two grains grown from both interfaces of the silicon region is adjacent to each other is generated i.e., a nuclei generating region (minute poly crystalline silicon particle region), as shown.

Through the above explained crystallization process using the first laser beam irradiation, the crystallized regions "D", "E" and "F" in one block as many as the number of the slits ("A" of FIG. 1) in the mask (38 of FIG. 1) are formed.

Subsequently, FIG. 3b is a view showing grain growth features by a second laser beam irradiation.

After the first laser beam irradiation, the X-Y stage (46 of FIG. 1) or the mask moves by a distance less than the lateral grain growth length at one side with respect to the nuclei generating region, and then, the second laser beam irradiation is performed.

The reason for the above explained is that if the laser beam pattern formed by the mask is adjacent to the nuclei generating region 50, the nuclei act as seeds and a crystal different from the crystal formed by the first laser irradiation is grown

In such case, the crystallization growth of the grain cant not be further progressed.

Therefore, in order that the laser beam pattern covers the nuclei generating region (50 of FIG. 3a), the laser beam pattern (mask pattern) moves by the distance less than the lateral grain growth length i.e., equal to or less than 1 micrometers (μm).

Therefore, a portion of the silicon irradiated with the second laser beam covers a large portion of the crystallized region and the amorphous region, and the two regions are liquefied and then crystallized.

At this point, the silicon grain (58a of FIG. 3a) of the poly crystalline silicon region formed by the first irradiation continues to grow laterally into the silicon-melted region.

After the second laser beam irradiation, the silicon crystal 58b becomes a first grain region 60a grown by the first irradiation, a nuclei generating region 50a and a new second grain region 60b.

Therefore, by repeating the foregoing processes several times, as shown in FIG. 3c, the amorphous thin film corresponding to one block is crystallized to form the crystalline silicon thin film.

Further, by repeating the crystallization process block by block, the large area amorphous thin film is crystallized to form the crystalline thin film.

The grain having a long length of the lateral growth is formed by the above explained crystallization method. However, to obtain such long length of the lateral growth, the mask or the stage (not shown) must move minutely several times. Accordingly, to crystallize desirable area, the time required to move the mask or the stage occupies major part in the total process time, and thus this decreases manufacturing efficiency.

[TECHNICAL SUBJECT OF INVENTION]

Therefore, the present invention is proposed to solve the above explained problems.

The present invention proposes that a transmitting region pattern of a mask has a stripe shape extended in a horizontal direction and moves by a range from several hundred micrometers (μm) to several millimeters (mm) and thus crystallization is performed.

Such method of the present invention has a object to improve manufacturing efficiency by rapidly crystallizing the same area in comparison with the conventional art.

[CONSTRUCTION AND OPERATION OF INVENTION]

To achieve the object of the present invention, a crystallization method of a poly silicon according to the present invention includes preparing a first substrate where an amorphous silicon thin film is deposited; fixing the substrate to a fixing means; disposing a mask on the substrate, the mask having a transmitting region having a rod shape and having both edge portions having a shape that a width decreases and a shielding region; irradiating a laser beam to the mask, thereby irradiating a laser beam having a predetermined shape by passing through the transmitting region of the mask to the amorphous silicon thin film;

completely melting the region irradiated by the laser beam corresponding to a center portion of the transmitting region, and partially melting the region irraidated by the laser beam corresponding to both sides of the transmitting region; growing grains at interfaces of both sides between the completely-melted region and the amorphous silicon, thereby performing a first crystallization of forming a first crystallized region having a first grain region, a colliding region and a second grain region; moving the mask by a distance less than a horizontal length of the first crystallized region such that an edge portion of one side of the transmitting region overlaps a portion of the first crystallized region, and irradiating a second laser beam, thereby performing a second crystallization of crystallizing a region including the partially-melted region; performing a cyrstallization in the horizontal direction of the substrate in a same manner of the second cyrstallization; and moving the mask or the fixing means by a predetermined distance in a vertical direction when the crystallization in the horizontal direction of the substrate finished, and performing a same crystallization as said crystallization transversly to the horizontal direction, thereby finishing the crystallization.

The mask and the fixing means move in a X-direction or a Y-direction.

Both edge portions of the rod-shaped transmission region have a triangular shape or a semi-circular shape.

A lateral growth crystallization method according to the present invention includes forming an amorphous silicon on a insulating substrate; irradiating a first laser beam through the mask having a transmitting region having a rod shape and having both edge portions having a shape that a width decreases, thereby forming a first crystallized region; moving the transmitting region of the mask in the horizintal direction such that an edge portion of one side of the transmitting region pattern overlaps a portion of the first crystallized region, and irradiating a second laser beam; and forming a second crystallized region including a portion

of the first crystallized region and a new crystallizied region by the second laser beam. A beam pattern of the present invention is formed by a transmitting region of a mask, the mask having a shielding region and the transmitting region having a rod shape and having both edge portions having a shape that a width decreases.

Hereinafter, reference will now be made in detail to embodiments of SLS crystallization methods according to the present invention, examples of which are illustrated in the accompanying drawings.

-- First embodiment --

FIG. 4 is a schematic plan view showing a mask used for crystallization of poly silicon according to a first embodiment of the present invention.

As shown, a transmitting region "G" and a shielding region "H" of a mask 160 has a horizontal stripe shape, and a crystallization process is performed by using those.

At this point, a vertical length of the transmitting region "G" (i.e., a width of a beam pattern) is less than twice the maximum lateral grain growth length by one laser beam irradiation. A vertical length of the shielding region "H" (a distance between the beam patterns) is somewhat less than the vertical length of the transmitting region.

Accordingly, when the first laser beam is irradiated, the grains are grown laterally at both interfaces of an amorphous silicon layer, the boundaries of the lateral grown grains collide, and thus the lateral grain growth stops.

That is because the nuclei generating region including the minute poly silicon crystals differently from the first example of the conventional art is not generated when the beam pattern width is equal to or less than twice the maximum lateral grain growth length.

For crystallization process, the beam pattern passing through the mask 160 and reduced by the reducing lens (42 of FIG. 1) moves along a X-axis. The moving path is the horizontal length of the mask 160 i.e., the horizontal length of the beam pattern reduced by the reducing lens by from several hundred micrometers (μm) to several millimeters (mm), and thus the crystallization process is performed.

Accordingly, since the moving range of the mask or the X-Y stage in the X-direction increases, process time for the crystallization can decrease.

Hereinafter, with reference to FIGs. 5a to 5c, a crystallization method according to the conventional art is explained in detail. (The crystallization method using the above explained mask according to the first embodiment has a characteristic of crystallizing a large area in a short time.)

FIGs 5a to 5c are plan views showing poly silicon crystallization processes according to the first embodiment of the present invention.

At first, as shown in FIG. 5a, the mask 160 of FIG. 4 is disposed on the substrate 162, and then the first laser beam is irradiated, and thus crystallization for an amorphous silicon film deposited on the transparent insulating substrate 162 is performed.

At this point, a vertical length of the beam pattern passing the mask is equal to or less than twice the maximum lateral grain growth length "D" (a length of the grain).

A crystallized region corresponds to the transmitting region ("G" of FIG. 4). When the mask has the three transmitting regions, the crystallized regions "I", "J" and "K" each having predetermined horizontal length also are formed.

At this point, a crystallized phase in the crystallized regions "I", "J" and "K" is explained. The completely melted liquid phase amorphous silicon by the laser beam is crystallized by using the un-melted amorphous silicon of both sides as seeds. Accordingly, the

grains 166a and 166b are grown from the upper and lower portions in plane, and the boundaries of the grains collide near a dashed line 164.

When the first crystallization is finished, the stage (not shown) where the substrate 162 is placed moves by a distance less than the horizontal length "E" of the reduced mask pattern (beam pattern) in a millimeter unit, then a second laser beam is irradiated, and thus sequential crystallization in the X-direction is performed.

The moving distance is limited to a distance for overlapping an edge portion of the transmitting region and the crystallized region.

Therefore, the second laser beam pattern partially overlaps one ends of the crystallized region by irradiating the first laser beam.

At this point, a crystallization discontinuity is generated at a region "F" re-crystallized by overlapping the laser beam pattern.

Such phenomenon is caused by the shape of an edge portion of the transmitting region. When an edge portion of the transmitting region ("G" of FIG. 4) has a square shape, the laser beam pattern passing it melts the amorphous silicon film in a circular shape by the interference and scattering of the laser beam.

Accordingly, the grain is grown perpendicularly from the circular-shaped interface, and thus the grain in the edge portion is grown discontinuously compared to the grain in the center portion.

Subsequently, as shown in FIG. 5b, when crystallization in the X-direction is finished entirely, the mask moves minutely in the negative (-) Y-direction or the X-Y stage moves in the Y-direction.

Subsequently, by referring the finishing position of the first crystallization process as a first position, a laser irradiation process is performed once more in the horizontal direction.

In this manner, as shown in FIG. 5c, the crystalline silicon grain crystallized by the first process is further grown continuously. In other words, the grain continue to grow so that it has a length 165 half a distance between the grain colliding regions 164 of the crystallized regions ("I", "J" and "K" of FIG. 5a) by the first process.

Through the above method, crystallization for any region can be performed.

Since the crystallizing time of such method is rapid in the same area compared to the conventional method, it has an advantage of improving productivity.

However, when the amorphous silicon is crystallized by the above explained first embodiment, the poly crystalline silicon layer 168 includes multiple first regions "K1" having a normal phase grain, and second regions "K2" disposed between the first regions "K1" and having discontinuous grain growth features.

Accordingly, if the second regions "K2" are used for the thin film transistor, the active layer of the thin film transistor is formed by discontinuous crystals, and thus the electron mobility decreases remarkably compared to the normal thin film transistor.

If the thin film transistor having such characteristics is employed in the liquid crystal panel, the discontinuous operating characteristics will occur in the liquid crystal panel, and thus it is expected that the quality of the LCD device decreases.

Therefore, a second embodiment further improved than the crystallization method of the first embodiment is proposed.

-- Second embodiment --

Hereinafter, FIGs. 6a and 6b are plan views showing a mask according to a second embodiment of the present invention.

As shown, the mask 200 according to the present invention includes a shielding region 202 and a transmitting region 203.

The number of the transmitting region 203 may be multiple, a width "M2" of the shielding region 202 between the transmitting regions 203 is equal to or less than a width "M1" of the transmitting region.

At this point, the width "M1" of the transmitting region 203 is equal to or less than twice the maximum lateral grain growth length by a first laser beam irradiation.

The transmitting region 203 has a stripe shape extended in one direction. Both edge portions "L1" and "L2" of the transmitting portions 203 have a triangular shape "L1" and semicircular shape "L2", as shown in Figures 6A and 6B, respectively.

Due to such structures, portions corresponding to both sides of the laser beam pattern formed through the transmitting region 203 are not crystallized.

That is because the laser beam passing through the edge portions "L1" and "L2" has a slowly lowered laser energy by interference and scattering and the amorphous silicon regions corresponding to the edge portions "L1" and "L2" are not completely melted.

With reference to FIGs.7a to 7d, a crystallization method using the mask inducing the above explained crystallization characteristics according to the second embodiment of the present invention is explained.

FIGs. 7a to 7d are plan views showing a method of manufacturing a poly silicon.

At first, a buffer layer (not shown) as an insulating layer is formed on a substrate 220, an amorphous preceding film 222 is deposited.

Subsequently, the amorphous preceding film 222 is firstly thermal-treated for de-hydrogenation.

Subsequently, as shown in FIG 7a, a laser beam having the complete melting regime is irradiated so that the amorphous silicon region corresponding to the beam pattern is melted.

When the molten amorphous silicon is cooled, the grains are generated from the interfaces of both sides between the molten region and the amorphous silicon layer.

At this point, since a width "O1" of the molten region is twice the maximum grain growth length (a grain growth length by irradiating one laser beam), a minute nuclei generating region is not generated in the complete melting regime and the first grain region "O2" and the second grain region "O3" collide each other.

At this point, since the amorphous silicon layer of the amorphous silicon region "P" corresponding to both sides of the laser beam pattern is slightly melted and cooled at its surface, it is almost not crystallized.

That is because the irradiated laser beam is interfered and scattered when passing through a narrow region and thus its energy density decreases, as explained above.

Subsequently, as shown in FIG 7b, the transmitting region 203 of the mask moves less by a distance than the horizontal length "R" of the first crystallized region, and then the laser beam is irradiated.

At this point, the edges of the transmitting region pattern 203 of the mask overlap a portion of the first crystallized region 223.

In this manner, one side of the second laser beam pattern overlaps a portion 228 of the normal grain growth region of the first crystallized region. Since the energy regime i.e., partial melting regime ~ near complete melting regime, at that portion 228, a surface of the crystallized layer of that portion 228 is slightly melted and re-crystallized like prior phase. Accordingly, though the beam patterns overlap, the normal crystallization phase is maintained.

Further, the abnormal crystallized region 226 of the first crystallized region 223 is complete-melted and re-crystallized, and thus it becomes the grain region 230 having the grains normally grown.

The above explained crystallization processes of FIG. 7b are performed continuously, and thus crystallization for the horizontal direction of the substrate is finished. Then, as shown in FIG. 7c, a fixing means (not shown) fixing the substrate 220 or a mask fixing means fixing the mask 200 moves minutely in the vertical direction. By referring the moved position as a start position, crystallization processes in the horizontal direction are performed.

In this manner, as shown in FIG. 7d, when the above explained processes are performed repeatedly, a poly silicon film 232 is formed on the entire substrate where multiple crystallized regions "Q" are formed and abnormal crystallized regions are not formed.

Through the above explained method, the amorphous silicon can be crystallized, and such method can be employed in driving devices or switching devices.

In general, when display resolution of the liquid crystal display device increases, a pad pitch of signal lines and scanning lines decreases, and thus bonding for a TCP (tape carrier package), which is general package for driving circuits, is difficult.

However, by using the crystallization method of the present invention, it is possible that a driving IC of poly silicon is formed directly on the substrate in the same process for semiconductors. When poly silicon is used for forming driving circuits directly on the substrate, costs for driving IC can decrease and package can be simple.

FIG. 8 is a schematic view showing a liquid crystal panel, in the substrate of which a data driving circuit 334a and a gate driving circuit 334b are packaged.

As shown, the liquid crystal panel includes a display portion 332 and a driving portion 335. The display portion 332 includes switching devices (not shown), and the driving portion 335 includes driving circuits 334a and 334b having CMOS devices.

The CMOS device is a MOS device comprised of an N-type transistor and a P-type transistor, which are driven by an inverter relative to each other in the normal totem pole fashion. Since the CMOS device has an advantage of consuming very little electric power, it is used for a driving circuit.

Since such CMOS devices require fast operating characteristics, the poly silicon layer is used for an active layer. When the switching device also uses the poly silicon layer as an active layer, high mobility is obtained and thus the liquid crystal panel has an advantage of the improved display quality.

The driving device and the switching device are fabricated at once. Hereinafter, it is explained with reference to the drawing.

FIG. 9 is a cross-sectional view showing the switching device and the CMOS device. In FIG. 9, the switching device "T" is shown in a left side, and the CMOS device "C" is shown in a right side.

Hereinafter, fabricating processes for the switching device and CMOS device is explained (the switching device uses N-type transistor).

At first, silicon nitride (SiNx) or silicon oxide (SiO_2) is deposited on a substrate 350, where a switching device region and a CMOS device region are defined, to form a buffer layer 152.

Subsequently, amorphous silicon (a-Si:H) including hydrogen is deposited on the buffer layer 352, and then de-hydrogenation process is conducted.

Subsequently, by using the above explained method according to embodiments of the present invention, the de-hydrognated amorphous silicon layer is crystallized to form a poly silicon layer. Subsequently, the poly silicon layer is patterned to have a predetermined shape.

The poly silicon layer is formed in the switching device region "T" and the CMOS device region "C" at once.

At this point, the patterned poly silicon layers in the respective device region "T" or "C" include active channel regions 354a, 356a and 358a and impurity regions 354b, 356b and 358b.

Subsequently, an insulating film 360 is formed on the patterned poly silicon layers 354, 356 and 358, and then gate electrodes 362, 364 and 366 are formed on the active regions 354, 356 and 358, respectively.

Subsequently, an interlayer 368 is formed on the entire surface of the substrate 350, where the gate electrodes 362, 364 and 366 are formed, and patterned to exposed the impurity regions 354b, 356b and 358b of the switching device "T" and the driving device "C" (N-type thin film transistor and P-type thin film transistor).

Subsequently, ions are doped in the exposed impurity regions 354b, 356b and 358b. Since the switching device is N-type and a first device "C1" of the driving devices "C" is N-type, other regions except for those regions are covered by means such as a photoresist, and then ion-doping process is conducted.

Subsequently, the regions doped by n+ ions are shielded, and the impurity region 358b of a second device "C2" of the driving devices is doped by p+ ions.

Subsequently, source electrodes 370a, 372a and 374a and drain electrodes 370b, 372b and 374b contacting the impurity regions of the respective devices are formed.

Through the above explained processes, the switching device "T" of the display portion and the CMOS device "C" of the driving portion are fabricated. A passivation film 376 as an insulating film is formed on the entire surface of the substrate 350, where the respective devices are formed, and the drain electrode 370b of the switching device "T" is exposed.

A transparent pixel electrode 378 contacting each drain electrode 370b is formed, and thus the liquid crystal panel is fabricated.

Since the active layer of the driving device and the switching device is formed by using the method of forming the poly silicon according to the present invention, process time can decrease.

[EFFECT OF INVENTION]

Therefore, when crystallization method according to the present invention is used for crystallizing amorphous silicon into poly silicon, there are effects as follows.

Firstly, since the crystallization is performed by moving by a distance of several hundred micrometers (μm) to several millimeters (mm) in a horizontal direction, the process time for the crystallization can decrease and productivity can be improved.

Secondly, since the crystallization is performed by using the mask including multiple transmitting regions extended in one direction and having a triangular shape or an oval shape at both sides, superior quality poly silicon film having the normally grown grains can be formed from the amorphous silicon film corresponding to both edge portions of the transmitting region.

Thus, the driving device or the switching device having normal operating characteristics can be fabricated.

[RANGE OF CLAIMS]

[CLAIM 1]

A crystallization method of a poly silicon, comprising:

preparing a first substrate where an amorphous silicon thin film is deposited;

fixing the substrate to a fixing means;

disposing a mask on the substrate, the mask having a rod-shaped transmitting region in a horizontal direction and a shielding region;

irradiating a laser beam to the mask, thereby irradiating a laser beam having a predetermined shape by passing through the transmitting region of the mask to the amorphous silicon thin film;

completely melting the region irradiated by the laser beam corresponding to a center portion of the transmitting region, and partially melting the region irraidated by the laser beam corresponding to both sides of the transmitting region;

growing grains at interfaces of both sides between the completely-melted region and the amorphous silicon, thereby performing a first crystallization of forming a first crystallized region having a first grain region, a colliding region and a second grain region;

moving the mask by a distance less than a horizontal length of the first crystallized region such that an edge portion of one side of the transmitting region overlaps a portion of the first crystallized region, and irradiating a second laser beam, thereby performing a second crystallization of crystallizing a region including the partially-melted region;

performing a cyrstallization in the horizontal direction of the substrate in a same manner of the second cyrstallization; and

moving the mask or the fixing means by a predetermined distance in a vertical direction when the crystallization in the horizontal direction of the substrate finished, and performing a same crystallization as said crystallization transversly to the horizontal direction, thereby finishing the crystallization.

[CLAIM 2]

The method according to claim 1, wherein the mask and the fixing means move in a X-direction or a Y-direction.

[CLAIM 3]

The method according to claim 1, wherein both edge portions of the rod-shaped transmitting region have a shape that a width decreases.

[CLAIM 4]

The method according to one of claims 1 and 3, wherein both edge portions of the rod shape have a triangular shape or a semi-circular shape.

[CLAIM 5]

A thin film transistor, comprising an active layer crystallized by a method of claim 1, a gate electrode, a source electrode and a drain electrode.

[CLAIM 6]

A CMOS device, comprising a P-type thin film transistor and an N-type thin film transistor including an active layer crystallized by a method of claim 1, a gate electrode, a source electrode and a drain electrode, the active layer of the P-type thin film transistor doped by p+ ions at both sides and the active layer of the N-type thin film transistor doped by n+ ions at both sides.

[CLAIM 7]

A lateral growth crystallization method, comprising:

forming an amorphous silicon on a insulating substrate;

irradiating a first laser beam through a mask having a transmitting region having a rod shape in a horizontal direction, thereby forming a first crystallized region;

moving the transmitting region of the mask in the horizintal direction such that an edge portion of one side of the transmitting region pattern overlaps a portion of the first crystallized region, and irradiating a second laser beam; and

forming a second crystallized region including a portion of the first crystallized region and a new crystallizied region by the second laser beam.

[CLAIM 8]

The method according to claim 7, wherein both edge portions of the rod-shaped transmitting region have a shape that a width decreases.

[CLAIM 9]

The method according to one of claims 1 and 8, wherein both edge portions of the rod-shaped transmitting region have a triangular shape or a semi-circular shape.

[CLAIM 10]

A laser beam pattern formed by a transmitting region of a mask, the mask having a shielding region and the transmitting region having a rod shape in a horizontal direction.

[CLAIM 11]

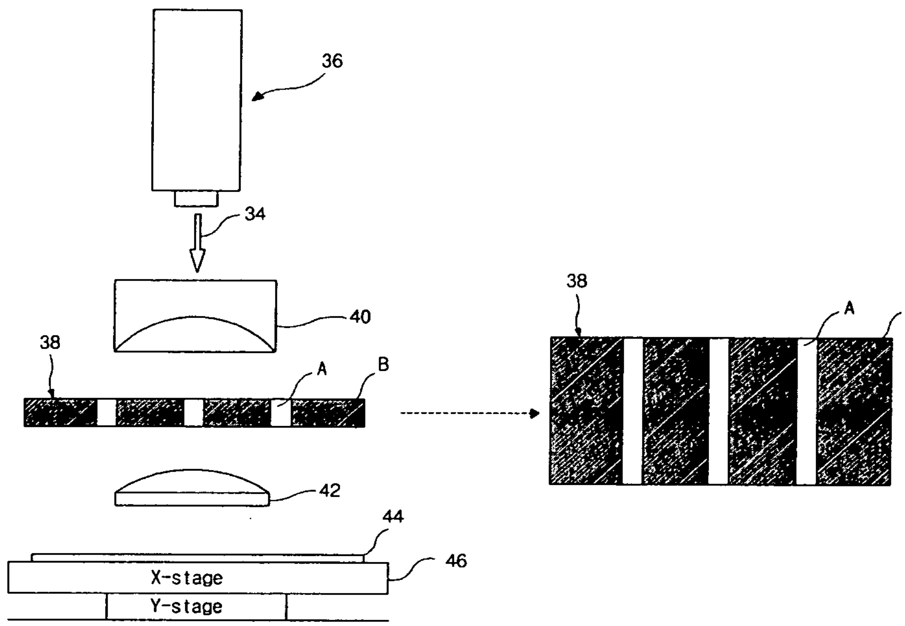
The pattern according to claim 10, formed by the rod-shaped transmitting region including both edge portions having a shape that a width decreases.

[CLAIM 12]

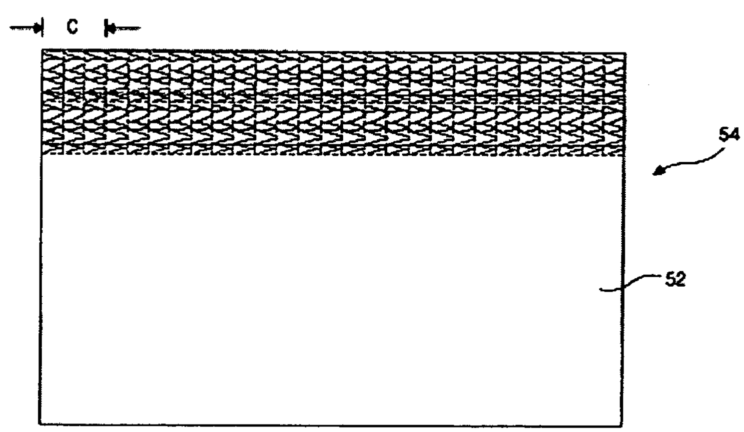
The pattern according to one of claims 10 and 11, formed by the transmitting region including both edge portions having a triangular shape or a semi-circular shape.

[DRAWINGS]

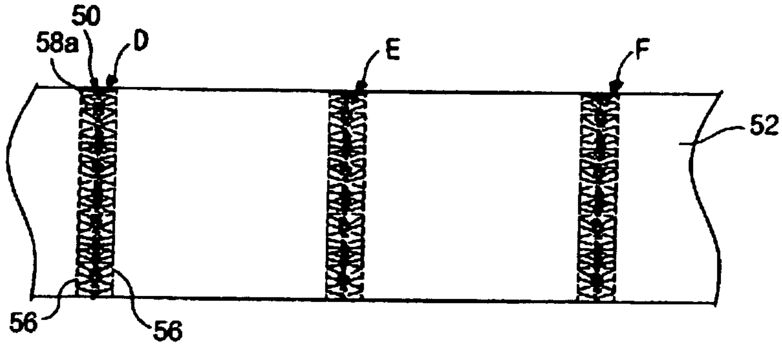
[FIG. 1]



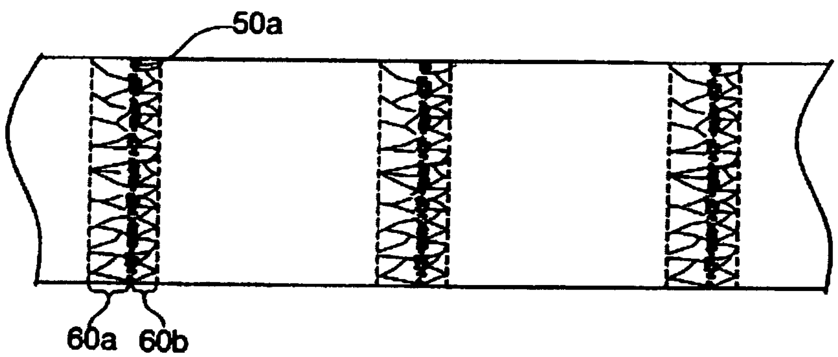
[FIG. 2]



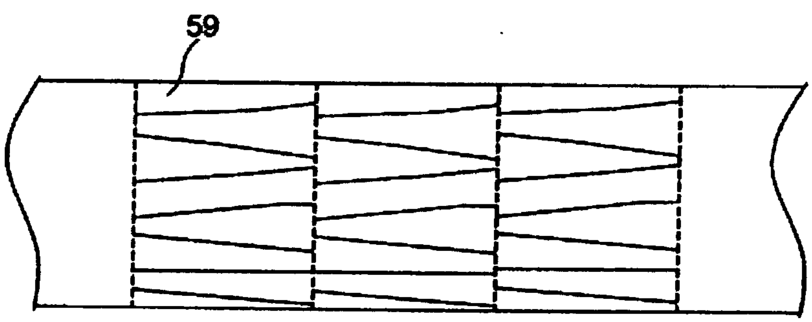
[FIG. 3 a]



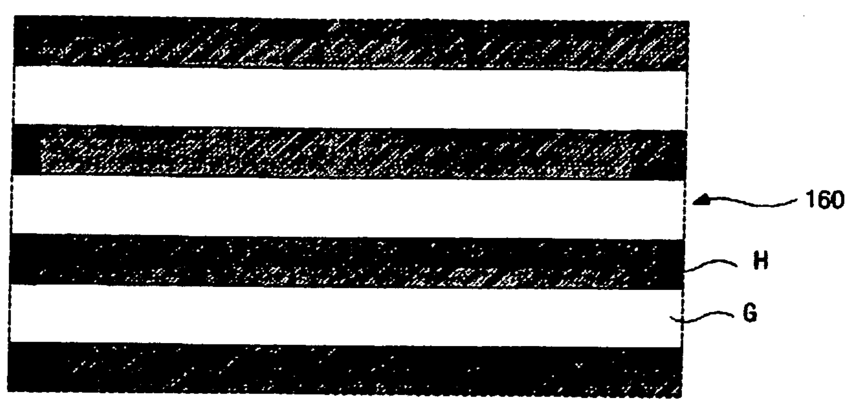
[FIG. 3 b]



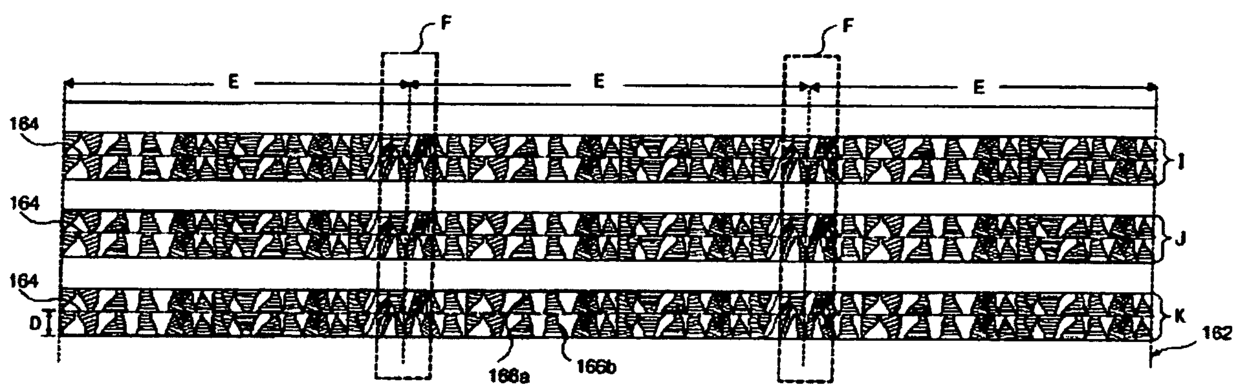
[FIG. 3 c]



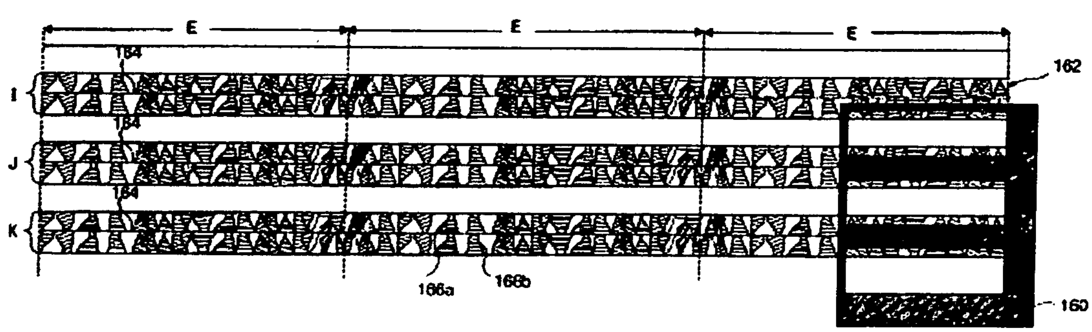
[FIG. 4]



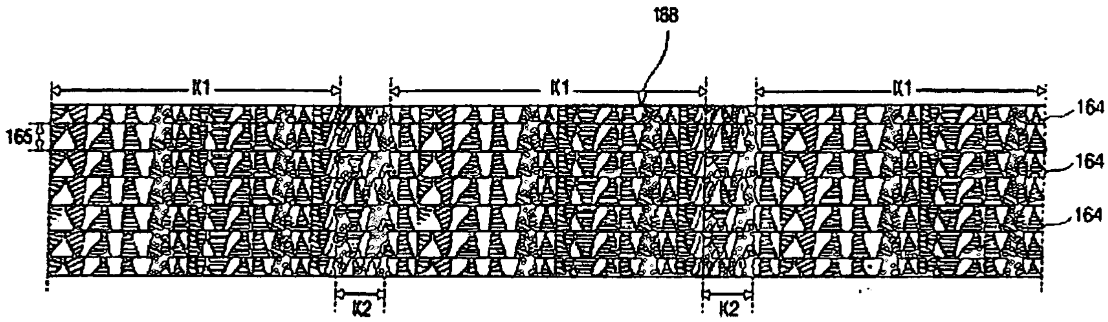
[FIG. 5a]



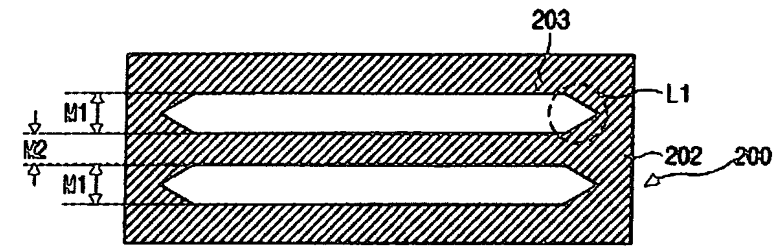
[FIG. 5b]



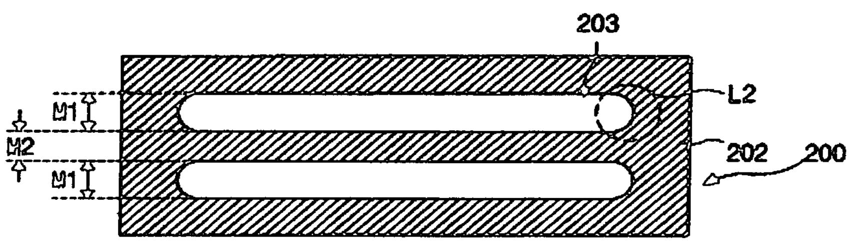
[FIG. 5c]



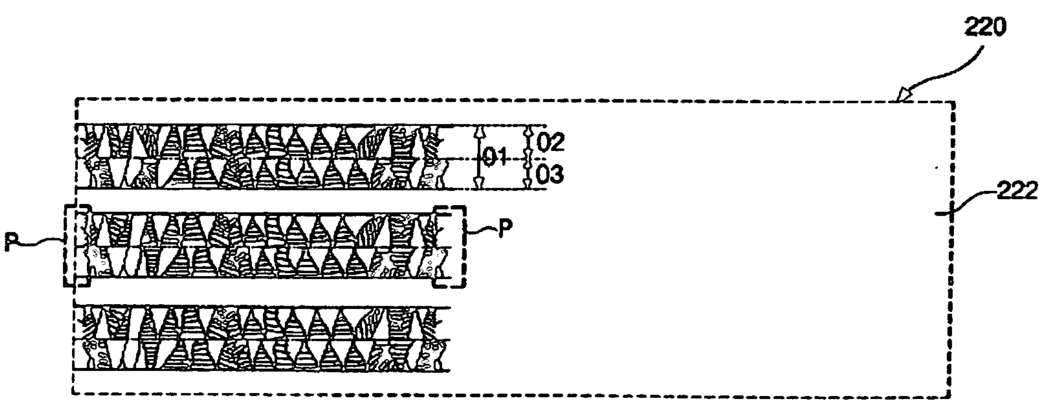
[FIG. 6a]



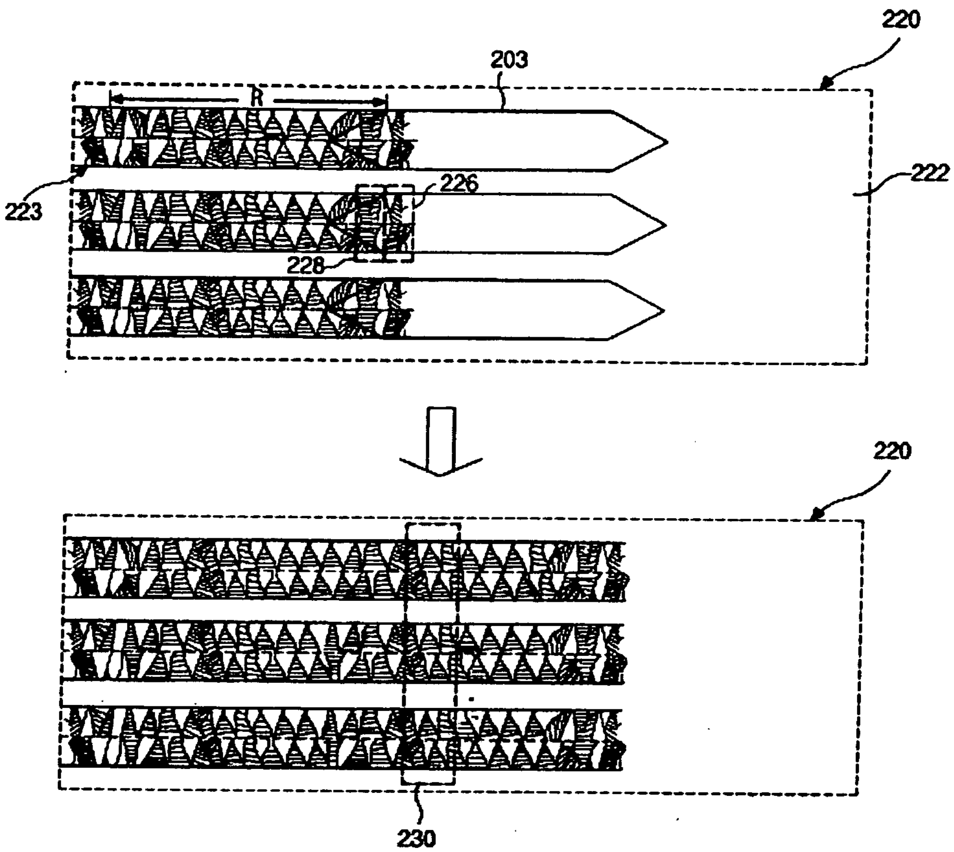
[FIG. 6b]



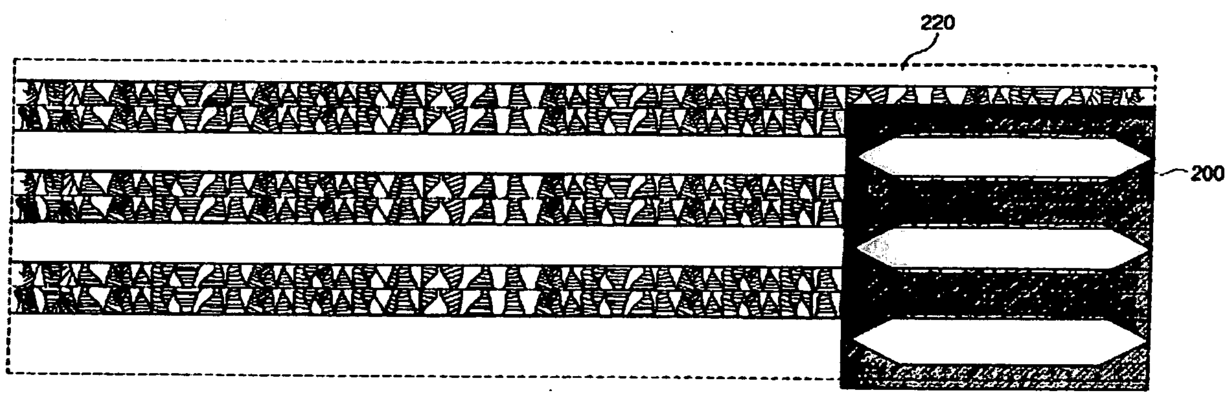
[FIG. 7a]



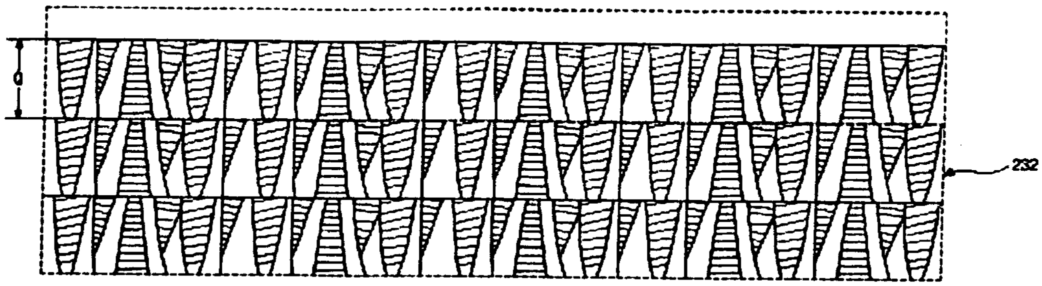
[FIG. 7b]



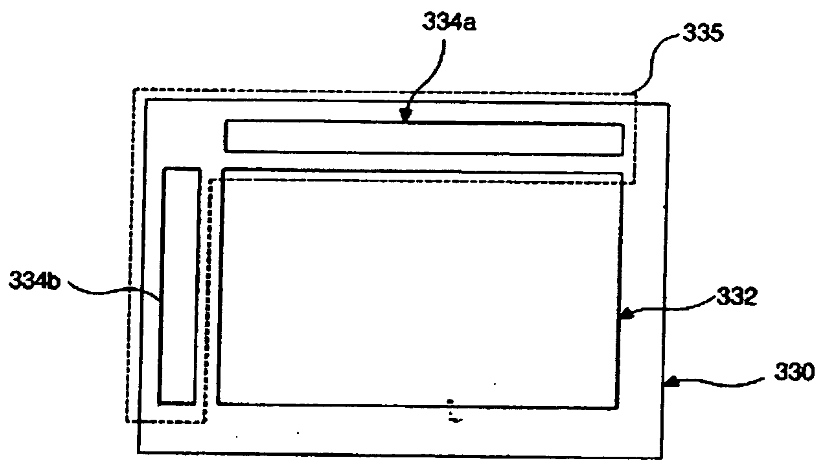
[FIG. 7c]



[FIG. 7d]



[FIG. 8]



[FIG. 9]